

Impact of detailed experimental uncertainty quantification and previously unknown biases on the evaluation of the ^{239}Pu PFNS and benchmark calculations

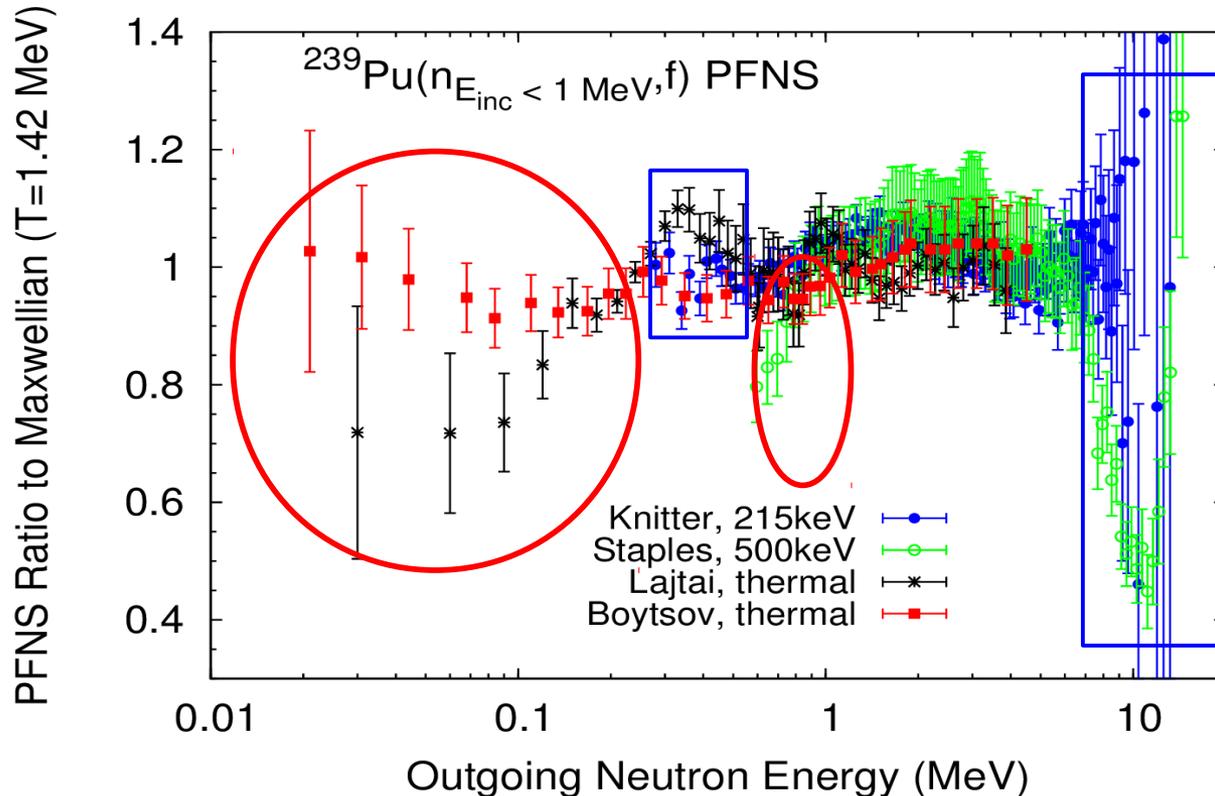
CSEWG meeting

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M.C. White, D. Neudecker, T.N. Taddeucci,
R.C. Haight, H.Y. Lee, M.E. Rising

Part of upcoming paper: D. Neudecker, T.N. Taddeucci, R.C. Haight, H.Y. Lee, M.C. White, M.E. Rising, Nuclear Data Sheets, to be published January 2016.

A new evaluation of the ^{239}Pu PFNS is performed as candidate for CIELO and ENDF/B-VII **BUT ...**

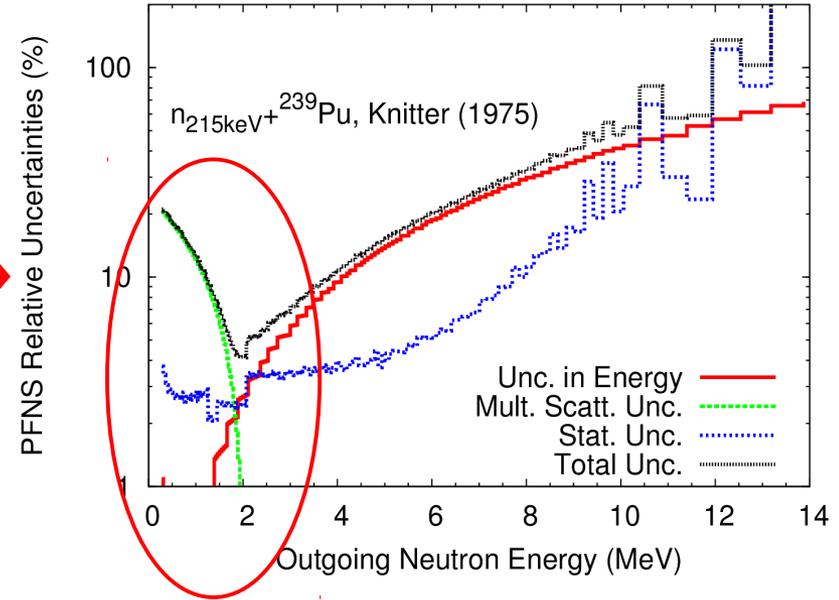
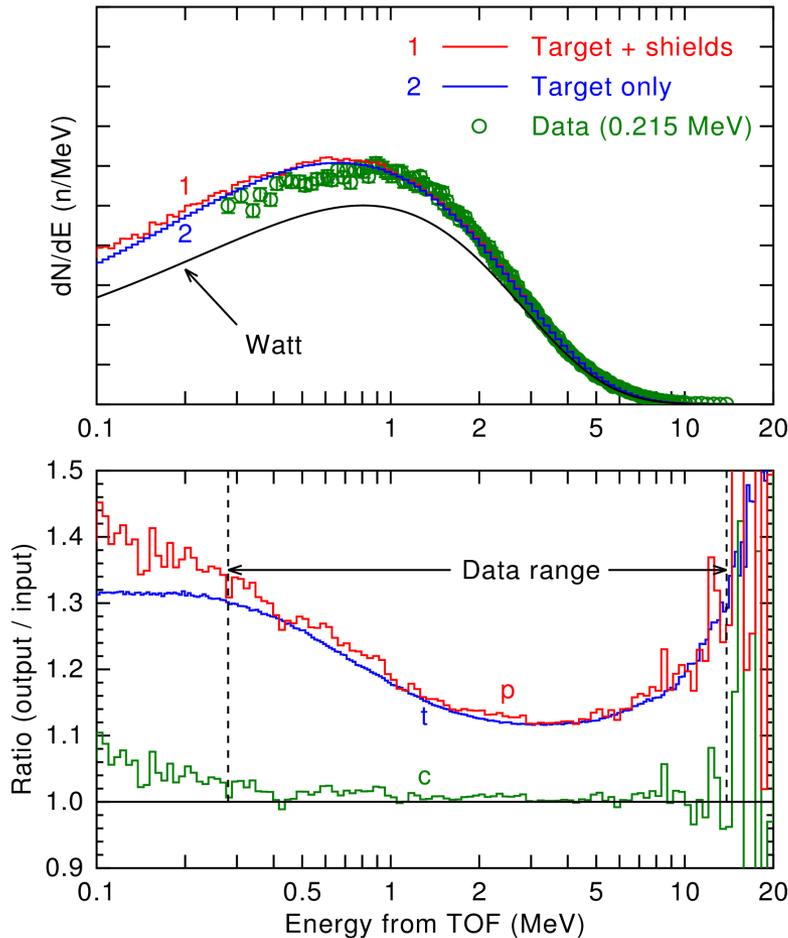


... experimental data for the ENDF/B-VII.1 evaluation disagree with more than their 1σ error bars!!!

MCNP studies were undertaken for legacy experiments:

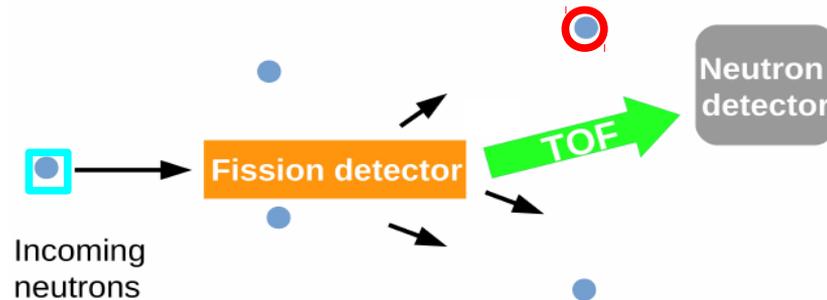
- ◆ Knitter: multiple scattering in the sample and collimators was studied (original: small correction)
- ◆ Staples et al.: multiple scattering in the sample and collimators was studied (original: no correction, assumed to be < 1%)
- ◆ Lajtai et al.: background correction using a shadow cone was studied (original: assumed to be perfect absorber)
- ◆ Starostov, Nefedob, Boytsov et al.: multiple scattering in the sample and collimators was studied (original: correction using ^{252}Cf PFNS data)

e.g., Knitter: MCNP studies uncovered substantial biases! → added unc.



Similar effect in Staples et al. data, Lajtai et al.: background is overestimated

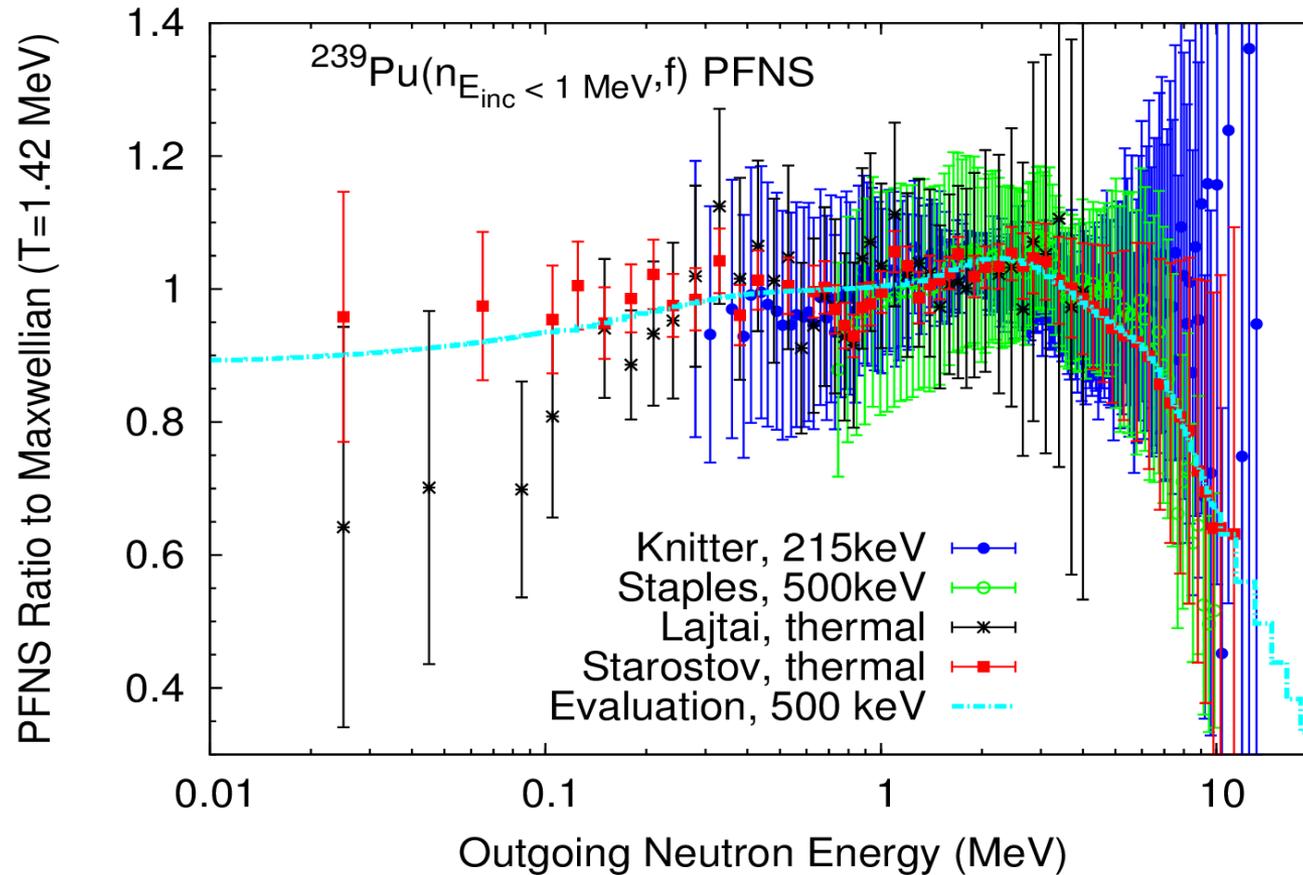
Covariances are estimated in detail for the same and between different experiments.



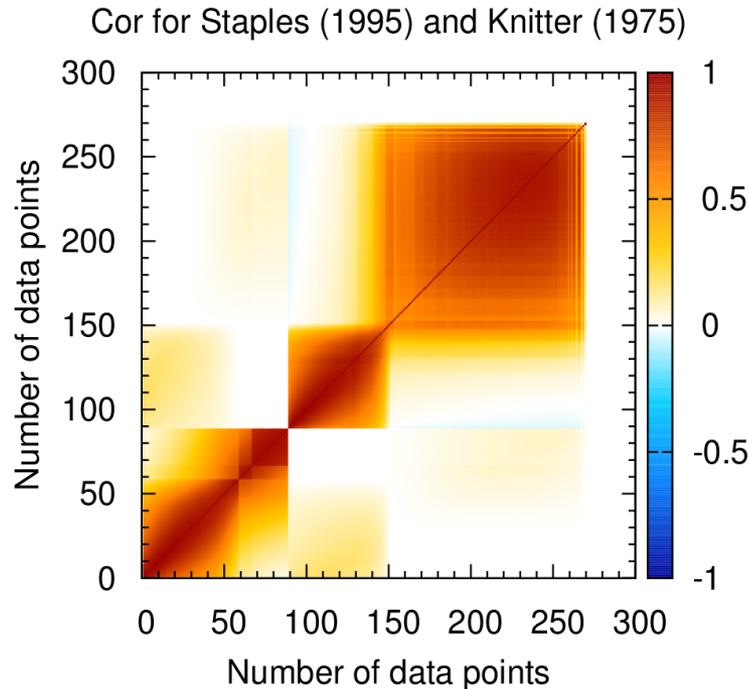
$$Cov^{\text{exp}} = Cov^{\text{Count. Stat.}} + Cov^{\text{Backgd}} + Cov^{\text{Mult. Scatt.}} + Cov^{\text{TOF}} + Cov^{\text{Det. Eff.}} + \dots$$

- Covariances are estimated by **parting uncertainties according to their different sources** and estimating correlations for them. **Uncertainties between different experiments** are estimated analogously. (recommended procedure!)
- **Additional uncertainty sources** are added.

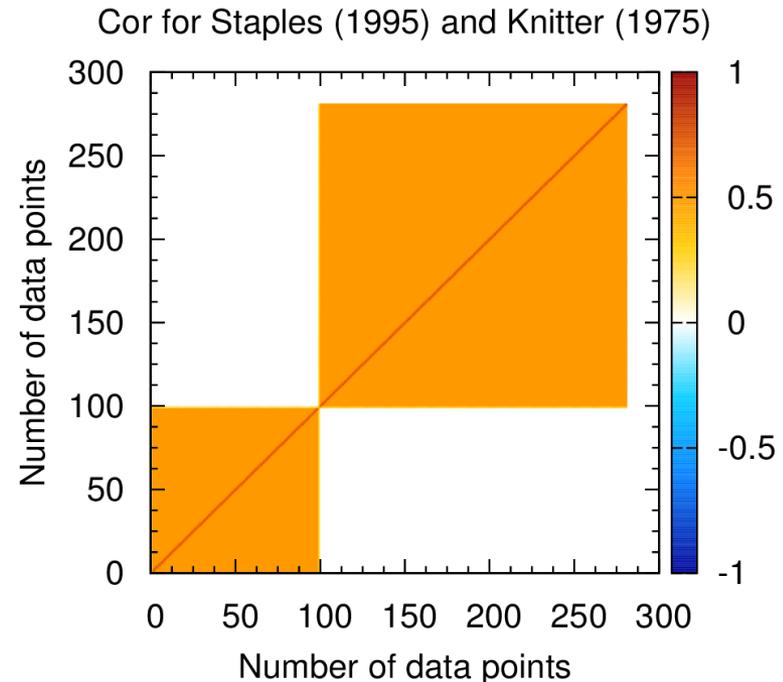
Info from MCNP studies and detailed exp. UQ → error-bars overlap



Resulting covariances differ distinctly from simplified estimate of 2010.



Current → used as input for new evaluation

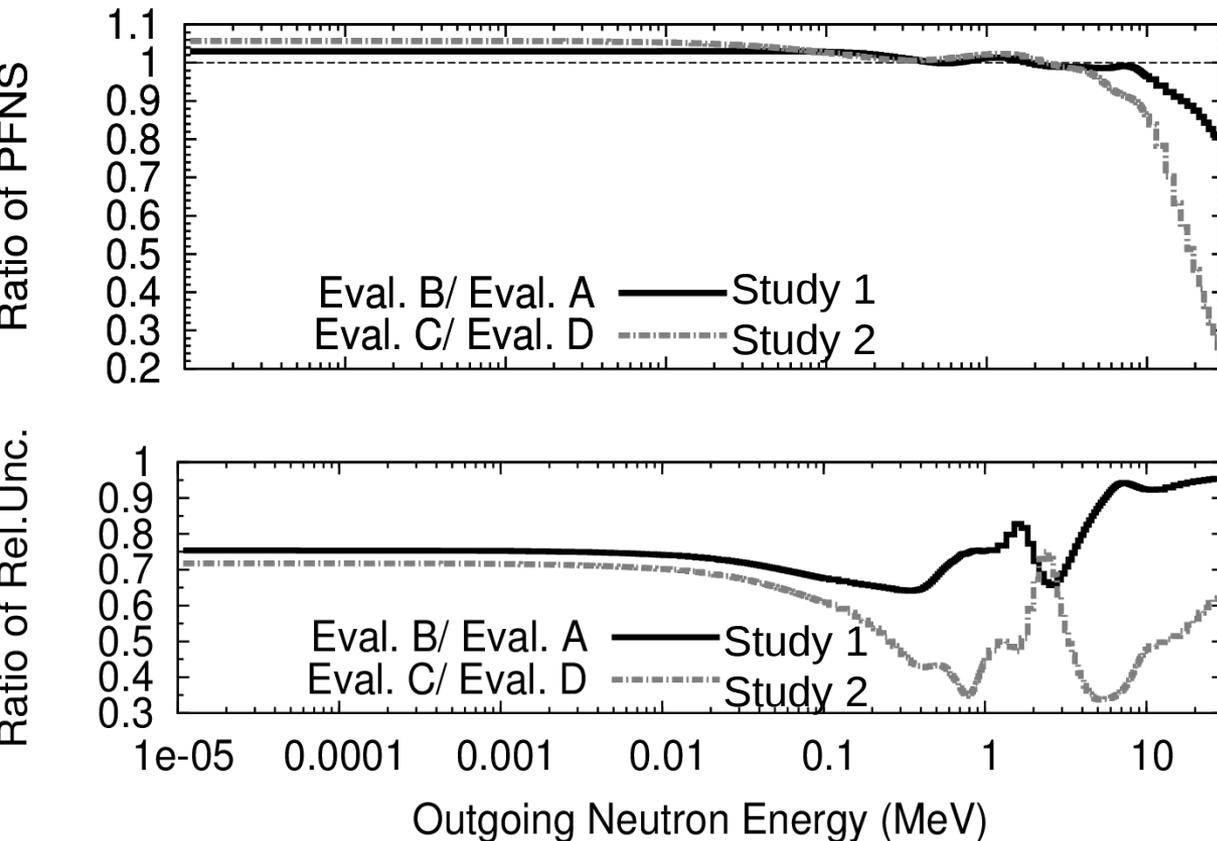


2010 → used as input to evaluate ENDF/B-VII.1 cov.

We study the impact of improvements on the evaluation of the $^{239}\text{Pu}(n_{500\text{keV}})$ PFNS by:

- ◆ For all test evaluations, the Generalized Least Squares methodology is used and the same Los Alamos model predicted prior data and covariances.
- ◆ Study 1: (A) Current covariances and data are used.
(B) Current covariance ***without uncertainties predicted according to MCNP*** studies and same data are used.
- ◆ Study 2: (C) ***Covariances and data of 2010*** are used.
(D) Current covariances of same data are used.

Additional uncertainties due to MCNP studies & detailed UQ impact eval. Data and uncertainties.



A~D ... Full exp. UQ

B ... Detailed UQ
WITHOUT unc. due
to MCNP studies

C ... 2010 exp. data
(no MCNP input,
simple UQ)

Additional uncertainties due to MCNP studies and detailed UQ impact benchmarks and unc.!

Change	Fast		Intermediate		Thermal	
	PMF1	PMF1 unc	PMF6	PMF6 unc	PST21	PST21 unc
Study 1	-67 pcm	-19 %	-67 pcm	-19 %	+205 pcm	-24.3%
Study 2	-195 pcm	-69 %	-229 pcm	-69 %	+510 pcm	-69 %

Summary

- ◆ Significant **discrepancies in ^{239}Pu PFNS legacy experimental data** were found to stem from **inadequate multiple scattering and background corrections**.
- ◆ **Detailed UQ** and unc. due to **previously unknown biases** have a significant **impact on evaluated data, benchmarks and their uncertainties**.
- ◆ Improved unc. information is included in new evaluation of ^{239}Pu PFNS for $E_{\text{inc}} = \text{thermal-30 MeV}$ (CIELO-C file)

D. Neudecker, T.N. Taddeucci, R.C. Haight, H.Y. Lee, M.C. White, M.E. Rising, Nuclear Data Sheets, to be published January 2016.